WATERCRESS IN FLORIDA

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Plants of what is loosely called watercress persist in springs, streams and swampy areas for long periods of time without flowering or fruiting and such populations are difficult to handle taxonomically. All too frequently, only leafy specimens from these populations are available and these reflect a tremendous vegetative variation from site to site as well as from one season to another.

In North America, perhaps the most complex and bewildering set of non-flowering populations is in northern Florida. This area abounds in suitable habitats for the persistence of non-flowering plants in spring pools, streams and otherwise permanent watery situations, particularly where there is a flow of some magnitude. In some of the clear mineral springs and their runs, watercress grows on the sandy bottoms, submerged and covered with two to four feet of water. Attempts to positively identify the watercresses of northern Florida have been frustrating for many years, so much so that the present study was undertaken to try to understand and explain the situation. Specimens from this region have been variously interpreted as belonging to *Cardamine* or *Nasturtium* (or sometimes *Rorippa*). Fortunately, Dr. Robert K. Godfrey, recently of Florida State University, has been interested in the problem. He has provided special mass collections that have helped to delineate the variation present at several different sites. I am grateful to him for this important help.

FIELD AND GREENHOUSE OBSERVATIONS

In the early spring of 1973, I made observations at three sites in northern Florida: below Wadesboro Spring, Clay County; at Ichetucknee Spring and run, Ichetucknee State Park, Columbia County; and Alexander Springs, Lake County. Living material was taken from the latter site for further study. The water was cool to cold and swift-running at each of the sites visited.

In all three places, plants growing fully submerged possessed entire, nearly orbicular leaves. In shallower water, where branches became emergent, the leaves were pinnately lobed on the emergent parts of the plants. This dimorphism of leaf form has contributed

to taxonomic confusion concerning these plants. Non-flowering plants with entire leaves have usually been referred to the genus *Cardamine* while those showing lobing have been identified as either *Nasturtium* [*Rorippa*] or *Cardamine*.

Fragments of plants, rooting at the nodes, were brought to the greenhouse in Cambridge, Massachusetts. These were grown both deeply submerged and near the surface in the cool circulating water of a large concrete fish tank. True to form, the submerged plants continued for over a year to produce entire leaves. During late spring, 14 months after being transplanted from the wild populations, the emergent parts of the plants grown near the surface produced pinnately lobed leaves and flowers. The deeply submerged plants continued to produce entire leaves (Figures 1 & 2). This is a reversible development and may be, by manipulation, moved in either direction. When the emergent plants with lobed leaves were again wholly submerged to a depth of a foot or more, the new shoots produced entire leaves. When the submerged plants with entire leaves were brought ot the surface, the new emergent shoots produced lobed leaves. These simple manipulations were performed to test the authenticity of the field observations which were critical to an accurate identification of wild populations, and specimens in herbaria. As a result, we can safely associate the entire-leaved plants with the pinnately lobed plants and know in this instance that we were dealing with but a single taxon. No attempt was made to control water temperature, light intensity, or daylength, for our interests were not in the process but rather the nature and amplitude of leaf heterophylly exhibited by the plants.

Several aquatic angiosperms, for example, species of *Ranunculus* (Butcher, 1940; Bostrak & Millington, 1962), *Proserpinaca palustris* (Burns, 1904), *Armoracia* [Neobeckia] *aquatica* (MacDougal, 1914), and a number of others, produce divided leaves under water and either entire or somewhat more entire leaves out of water. In the case of the Florida plants the reverse is true. The entire leaves are the ones growing submerged and the pinnately lobed ones are those growing out of the water. The latter are associated with flowering. These facts alone have tended to mislead and cause a wrong interpretation of specimen material.

CARDAMINE VERSUS NASTURTIUM

Over a century ago there was confusion as to whether the taxa

Figures 1 and 2. *Nasturtium microphyllum* (Boenn.) Reichenb., *Rollins 7311* (GH). Both plants grown for 14 months in a concrete fish tank with circulating cool water. Figure 1, pinnately lobed leaves and inflorescences produced above water from shallowly grown plants. Figure 2, entire leaves and non-flowering shoot grown continuously submerged to a depth of more than one foot.

under consideration belonged to the genus *Cardamine* or to the genus *Nasturtium* and the situation has remained obscure down to the present. A quote from Gray (1880) will illustrate (p. 46), "an imperfect original specimen from Shuttleworth was mixed up with a Florida species, intermediate between *Cardamine* and *Nasturtium,* first received from Leavenworth without fruit, and referred in the Supplement to the first volume of Torrey & Gray's Flora to *N. officinale;* it was afterwards received from Buckley, then from Shuttleworth (Coll. Rugel), first as *Cardamine curvisiliqua* Shuttl., and again as *Nasturtium stylosum,* Shuttl." The specimens with the names on their labels referred to by Gray are in the Gray Herbarium. The name *Cardamine curvisiliqua* was given a description in Chapman's Flora (1887) but the first clear refer-

ence I have found to the plants in question from Florida is in the supplement to Torrey and Gray's Flora of North America, published in 1843.

Evidently Watson was uncertain as to the generic position of the plants when he prepared the treatment of *Cardamine* for the Synoptical Flora of North America (1895) because as Robinson (Syn. Fl., p. 156, footnote 3) points out, "This species, although referred by Dr. Watson to *Cardamine*, was not described in his manuscript." While inserting the species into the treatment of *Cardamine*, Robinson placed a question mark between the generic name and the specific epithet *curvisiliqua*, thus indicating his own doubt as to the placing of it in *Cardamine*. Schulz (1903) excluded *C. curvisiliqua* from *Cardamine*, and referred it to *Nasturtium*. He was undoubtedly aware that the specific epithet *curvisiliqua* had already been used in *Nasturtium* by Nuttall (Torrey & Gray, 1838) and a name transfer could not be properly made. Later Schulz (1936) accepted the name *Nasturtium stylosum* Shuttl., dating it from Gray's reference to the name as quoted above. However, there was no description given at that time. The name was not provided with even a few words of descriptive matter until Schulz himself did it (1936, p. 553) in an incidental way. By that time, the epithet *stylosum* was preoccupied by *Nasturtium stylosum* (D.C.) Schulz, based on *Cardamine stylosa* D.C. (1821). *Nasturtium stylosum* Shuttl. ex Schulz is essentially a *nomen nudum* as well as a later homonym.

For some years I have been aware of the unsatisfactory placement in *Cardamine* of what has been called *C. curvisiliqua* and the related *C. gambelli* of southern California and Mexico (Rollins, 1960). These two species are not properly placed in *Cardamine*. As indicated above, this situation was clearly recognized by Schulz, who excluded them from that genus. It is evident from his annotations of specimens in the Gray Herbarium that Fernald (1950) regarded "*Cardamine curvisiliqua*" to be nothing more than *Nasturtium officinale* R. Br., var. *microphyllum* (Boenn.) Thell. However, a more recent clarification of the American representatives of the true watercresses (as *Rorippa*) by Green (1962) did not take into account material filed under *Cardamine curvisiliqua* and this left the question of the Florida watercresses still unresolved.

The true watercresses have been treated as belonging to *Rorippa* when that genus is interpreted to include *Nasturtium*. However, there is a substantial basis for recognizing both *Rorippa* and *Nas-*

turtium. In the most recent treatment of North American *Rorippa*, Stuckey (1972) excluded *Nasturtium* from *Rorippa;* and both *Rorippa* and *Nasturtium* were recognized in Flora Europaea (1964). On the other hand, as indicated above, Green treated the watercresses in the genus *Rorippa*. In many annotations of herbarium material, I have followed Green's treatment. However, it has become increasingly clear that the watercresses form a tightly knit small group of species that are only marginally related to members of the genus *Rorippa*. The true watercresses are *Nasturtium officinale* R. Br. and *N. microphyllum* (Boenn.) Reichenb. These and the gambel watercress, *N. gambelli* (Wats.) Schulz, make up the genus *Nasturtium* as it is presently known in North America.

Nasturtium gambelii and specimens of *N. microphyllum* have repeatedly been referred to *Cardamine* but neither of them possess the elastic valve that is so characteristic of *Cardamine*. Furthermore, in these species, the valve covers the replum and extends to the margin of the silique without intruding into the valvular area. In these respects they differ markedly from *Cardamine* where the valve often opens elastically and even if not, the valve upon discharge leaves a definite extension of the replum into what is the usual valvular area of the silique. It is my conclusion that these species are not properly placed in *Cardamine* and that the Florida material often identified as *Cardamine curvisiliqua* Shuttl. ex Chapm. is in reality *Nasturtium microphyllum* (Boenn.) Reichenb.

There are five taxa (one of which is a hybrid) in Florida that are involved in the various and uncertain interpretations applied to plants loosely called watercress when in the non-flowering condition. Two of these are in fact species of *Cardamine* which can be readily identified if they are in fruit. In flower, identification is more difficult but the anthers of the *Cardamine* species are much shorter and smaller than those of *Nasturtium*. The cardamines are annual and except in the young stages of growth, usually are in flower or fruit during the normal growing season. Insofar as I am aware of it, *Cardamine* does not grow fully submerged for any length of time and neither species forms mats in flowing water. The species tangentially involved in the problem are *C. pensylvanica* (var. *pensylvanica* and var. *brittoniana*) and an as yet unidentified species, probably an introduction from Europe or Asia.

Most of the non-flowering material encountered is *Nasturtium microphyllum* (Boenn.) Reichenb. However, *N. officinale* R. Br.

is found in a number of locations and it is not known whether some entire-leaved non-flowering plants are certainly referrable to the species or not. In fruit, the two species, one a diploid (*N. officinale*), the other a tetraploid (*N. microphyllum*), are easily distinguished from each other. Green (1962) has a full discussion of these closely related species and should be consulted for details.

Nasturtium officinale and *N. microphyllum* do hybridize and the offspring of the cross is a triploid. It is sterile, producing unfilled siliques. Specimens of the hybrid, the fifth of the five taxa mentioned above, have been seen from Florida. The siliques remain undeveloped in hybrid plants but nothing is known about the contribution of the hybrid to the non-flowering populations discussed above. Shaw (1948) has provided the name *Rorippa* × *sterilis* for the hybrid and in *Nasturtium*, it is *N.* × *sterile* (Shaw) Oefel.

Assuming that I am correct in referring what has at times been called *Cardamine curvisiliqua* to *Nasturtium microphyllum*, the question naturally arises as to why a species long treated as being a native of Florida is now considered to be an introduced species. The records show that the diploid *N. officinale* was introduced into the United States at least by the early 1800's and most likely arrived much earlier. Since both *N. officinale* and *N. microphyllum* have been prized as salad plants in Europe for centuries, it is not surprising that either or both of them should have been brought to the United States for the same purposes by the early settlers. The 1840 reference by Gray to plants from Florida now known to be *N. microphyllum*, as mentioned above, is not so surprising when viewed from this perspective.

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